Phys 741
Statistical Mechanics
Problem Set # 6

Dr. Gassem Alzoubi

The Hashemite University Department of Physics, Zarqa, Jordan

1. Pathria 6.1

2. *Summing infinite geometric series.* Consider the following infinite geometric series

$$\sum_{n=0}^{\infty} x^n = \frac{1}{1-x}$$

(a) Show that

$$\sum_{n=0}^{\infty} n x^n = \frac{x}{(1-x)^2}$$

(b) Show that

$$\sum_{n=0}^{\infty} n^2 x^n = \frac{x(x+1)}{(1-x)^3}$$

∗ *These series will help you answer the next problem*

3. Pathria 6.2

4. Consider a system of quantum gas in d dimensions with energy spectrum of $\varepsilon = c|k|^a$, where $c > 0$ and $a > 1$

(a) Calculate the grand potential Ω of the system

(b) Calculate the total energy U of the system, and show that the equation of state satisfies $PV = \frac{a}{d}U$. Verify this result for non-interacting classical ideal gas in 3d (see equation 6.11 in our lecture notes).

(c) Calculate the total number of particles in the gas N. Verify your result for non-interacting classical ideal gas in 3d (see equation 6.10 in our lecture notes).

Good Luck